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# EJECTION TOWER TEST FACILITY

PATUXENT RIVER, MARYLAND

Escape System Testing

Presented by:

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## OVERVIEW

- Tower history
- Facility description
  - Capabilities
  - Applications
- Recent projects
- Future initiatives

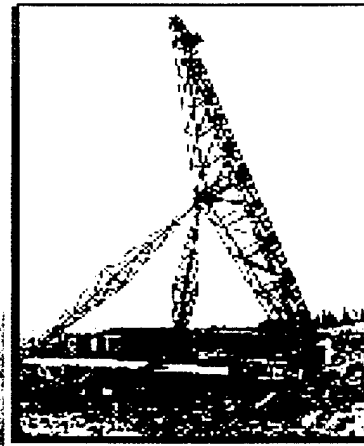
I will take questions at the end of the presentation.



## HISTORY



16 Feet Test Rig



65 Feet Test Rig  
Martin-Baker Aircraft, Denham

In 1944, as jet propulsion was being introduced to aviation and over-the-side bail out procedures less practical, Sir James Martin was invited by the British Royal Air Force to explore forced ejection. A 16 foot ejection tower was first used for this effort. A short time later a 65 feet test rig was erected at Martin-Baker Aircraft, Denham.

The first ejection tower in the United States was built at the Philadelphia Naval Yard in 1946 and was essentially the same design as the 65 foot tower used by Martin-Baker.



## HISTORY

(continued)



On 14 August 1946, the Aeronautical Medical Equipment Laboratory, BUMED, conducted the first live-subject ejection test using the tower at the Philadelphia Naval Yard. Subsequent tests using live subjects, established the human tolerance limit of approximately 25 Gs for forced ejection.



## HISTORY

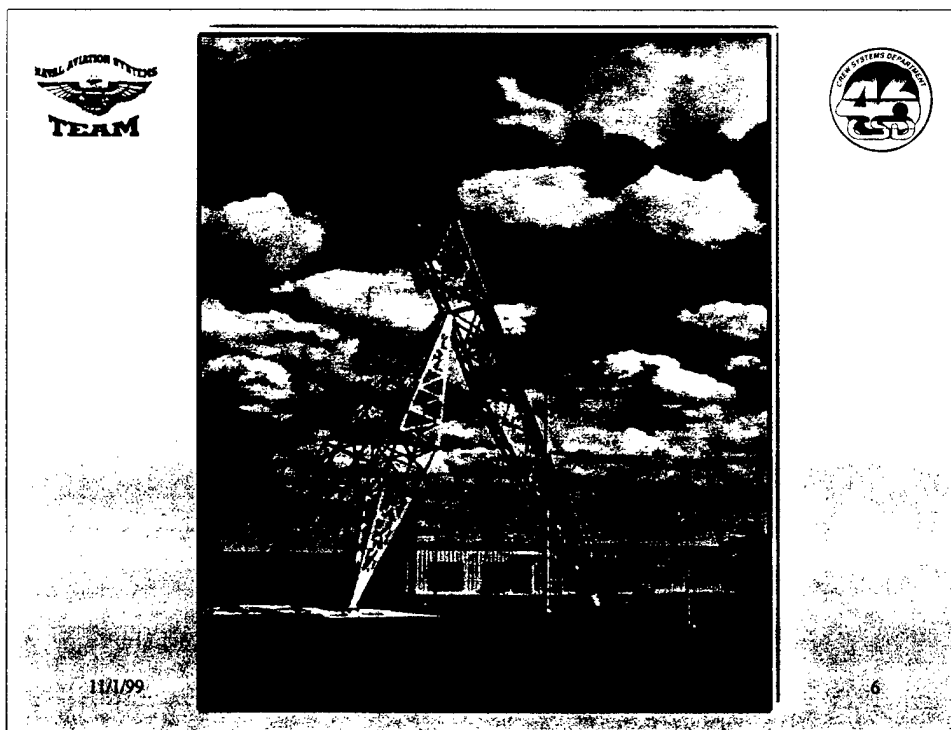
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- 1976 - The ejection tower was relocated to the Naval Air Development Center in Warminster, PA.
- 1996 - NADC Warminster, PA closed.
- 1996 - Construction of a new ejection tower facility begins at Patuxent River, MD and by April 1997 the lab is certified for operations.

In over 50 years of operation, in the United States, the ejection tower has executed over 7,000 tests, of which 4,500 were conducted using live subjects.

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#### DESCRIPTION

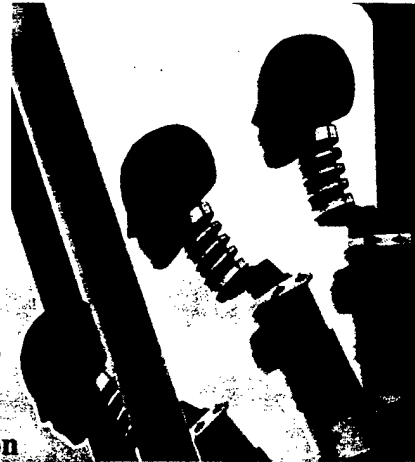
- HEIGHT 110 FEET
- INCLINATION 21 DEGREES
- ACCELERATION <16 g TYPICAL, 30 g MAXIMUM
- ONSET RATE <225 g/sec TYPICAL, 500 g/sec MAXIMUM
- PAYLOAD 600 POUNDS MAXIMUM
- WINCH OPERATED RECOVERY SYSTEM (HUMAN RATED)
- BALLISTICALLY OPERATED
- HONEYWELL - TEST MANAGEMENT SYSTEM 7000
  - 36 AVAILABLE DATA CHANNELS
    - 18 MOBILE
    - 9 GROUND
  - LINE SENSING
  - 10K Hz PER CHANNEL SAMPLING RATE
  - DIGITAL & ANALOG FILTERING
- MEDICAL EXAMINATION ROOM AND EQUIPMENT
- PREPARATION AND STORAGE AREAS
- LIGHT METAL WORK SHOP



## CAPABILITIES



- Catapult performance modeling
- Live subject testing
- Strain gaging
- Immediate high-speed digital imaging
- Quick plotting of sensor data
- Anthropomorphic Test Dummies (ATDs)
- Test fixture design and fabrication



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The single-based smokeless propellant can be easily modified to produce desired accelerations. The two-piece catapult is fitted with a fluted choke that can be adjusted to increase or decrease onset rates.

Cartridge:

Igniter: percussion primer

Booster Charge: black powder (pyralin cup next to percussion primer)

Main Charge: M6 nitrocellulose -87%

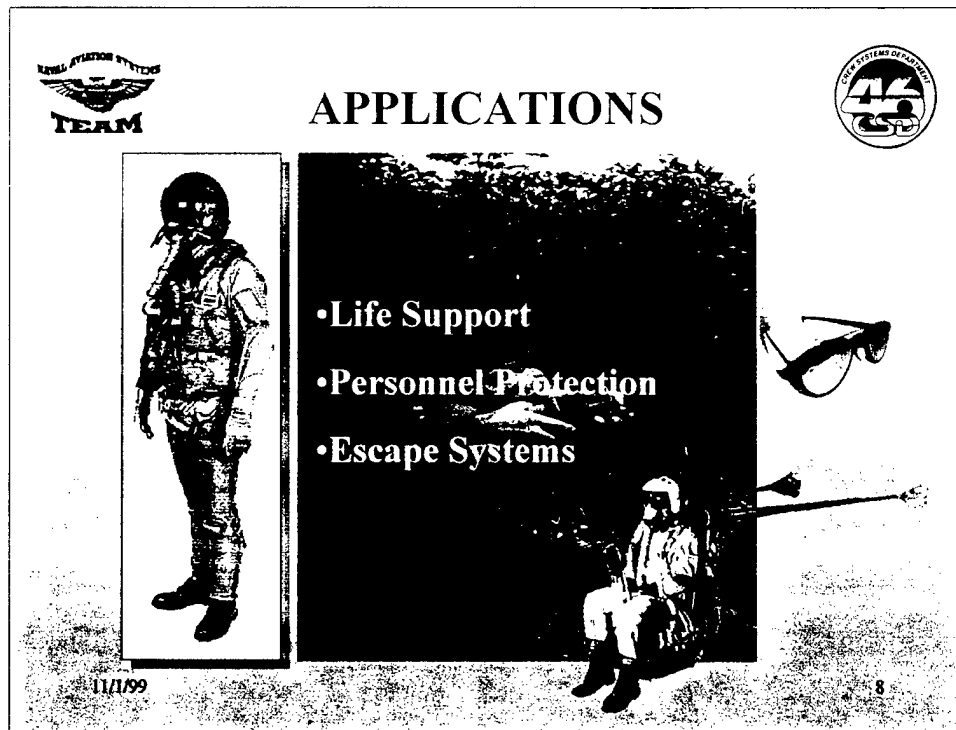
Cartridge uses a cup-type case crimped over a head with an o-ring gasket and lacquer for sealing.

OEM catapults can be adapted for proof of design and ballistic operation.

### •Live Subject

- Test subject evaluation
  - Independent review panels for the protection of human subjects
  - Facility test protocols and system safety analysis
  - Trained medical staff
  - Biomedical and optical monitoring
- Strain gaging for unique requirements. Off-the-shelf transducers may not be suitable.





- Life Support

- Oxygen Breathing Systems
- Personal Thermal Cooling
- Anti-g Upper/lower/Forced Air
- Biomedical Monitoring

- Personal Protection

- Head Protection
- Eye Protection
- Survival Equipment
- Parachutes
- Harness

- Escape Systems

- Restraints
- Structural
- Event Sequencing
- Ballistics
- Aircrew Accommodations (lumbar support, seat cushion, head support, etc.)



## Why Ejection Tower?



- Quantitative analysis
- Evaluation of system parameters
- Optimizes error separation and observability
- Acceleration test over a wide variety of requirements
- Risk reduction

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The ejection tower is an effective tool for:

- Quantitative Analysis
- Evaluation of System Parameters
- Optimizes Error Separation and Observability
- Acceleration Test Over a Wide Variety of Requirements
- Risk Reduction

System Parameters:

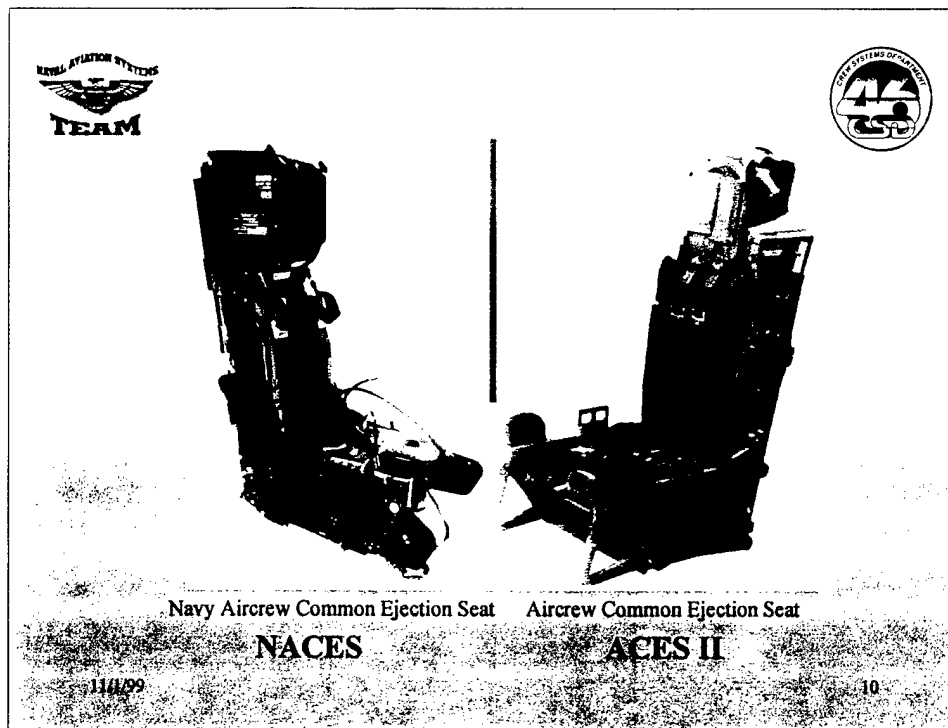
- Acceleration
- on-set rate
- velocity
- temperature
- pressure
- time

Error separation: controlled test configuration and execution.

**REPEATABILITY**

Risk reduction = assessments

- risk of injury
- design maintainability
- reliability
- Form, Fit, Function (preliminary)

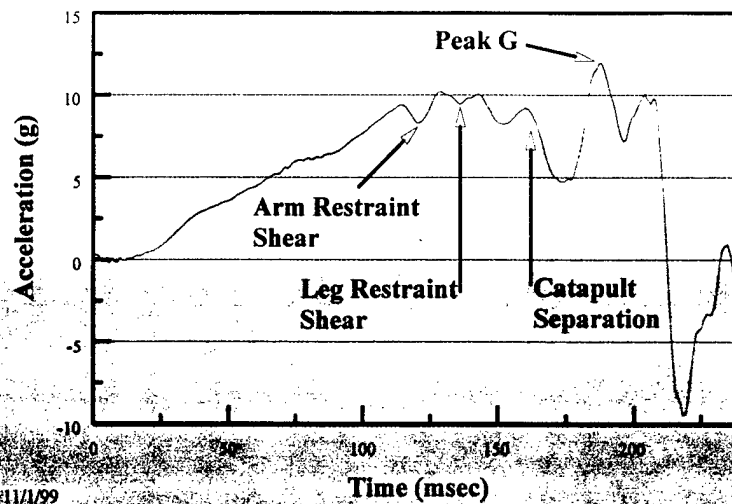


- NACES is the Navy's latest ejection seat and it is currently flown in the F-14D, F-18 C/D/E/F. This seat was tested on the ejection tower, located at NADC Warminster, PA, during the mid eighties. Structural, physiological, and integration tests were conducted as part of the overall qualification program. This included some tests using live subjects.

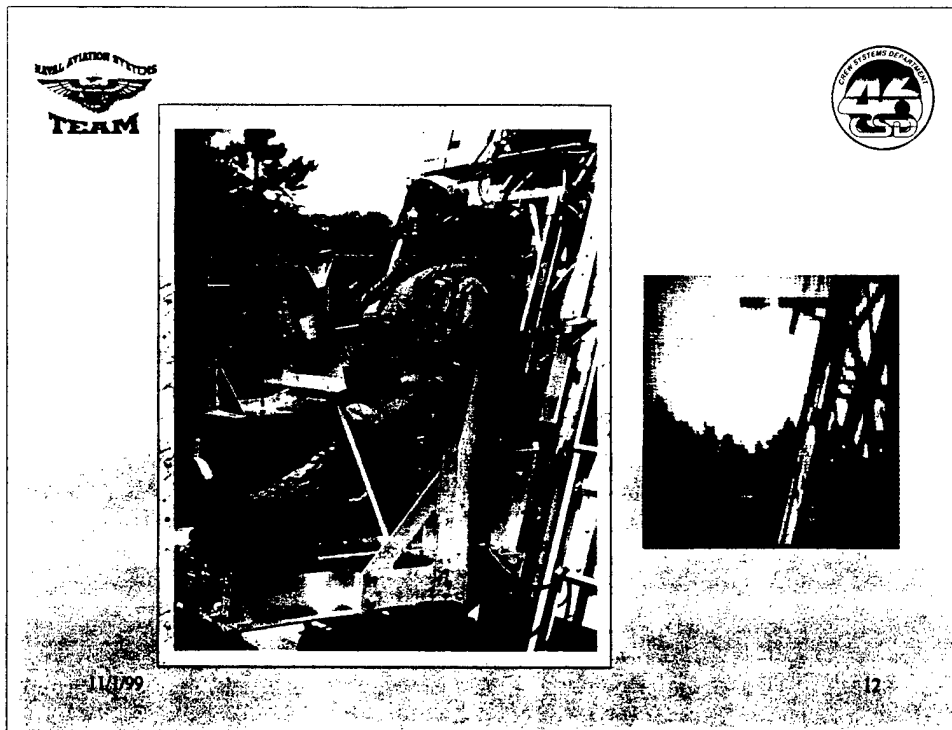
- ACES II is flown in Air Force Tactical aircraft like the F-15 Eagle, F-117 Nighthawk, and F-16 Falcon. It is planned that a version of this seat will be part of the low rate initial production of F-22 aircraft under acquisition by the U. S. Air Force.



## ACES II SEAT ACCELERATION



- Smoothing (typical)
  - 10 ms moving average
  - 5pts L&R windows
  - 10K Hz filter effect @ 1000 samples/sec



The ejection tower test facility is capable of a range of configurations from the most simple to complex. The configuration shown is from a recent project for the USAF F-22 acquisition program.

The left, forward, and right instrumentation panels along with a portion of cockpit floor and canopy sill representation are key crew station references used to evaluate ACES II developmental restraint systems for use in the F-22 aircraft.

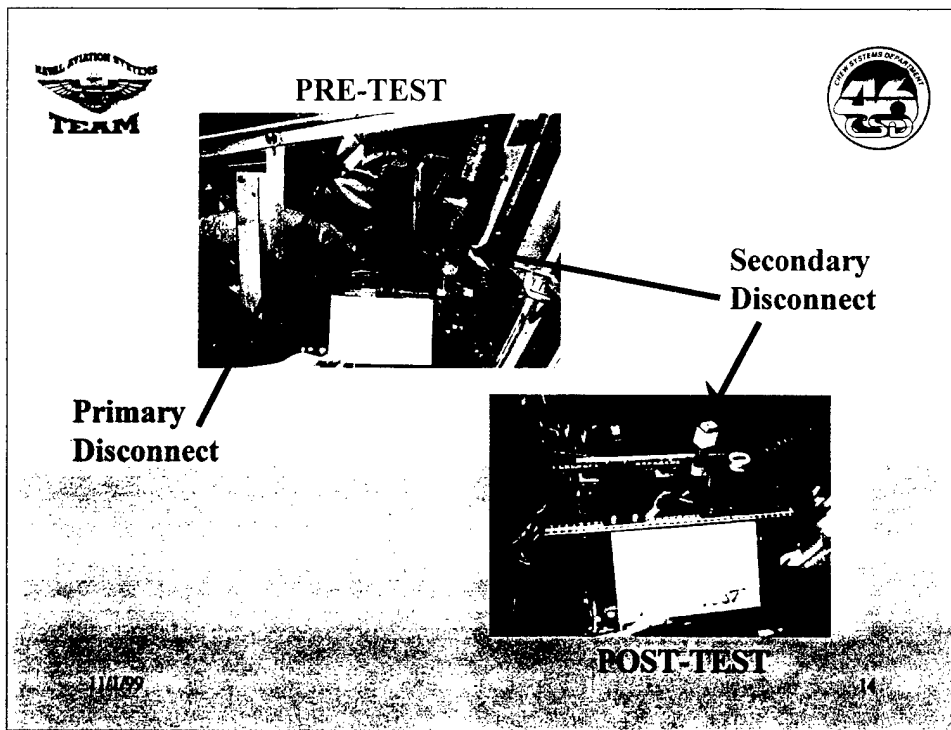
The movie clip shows a ballistic firing in real time.

A compliment of high-speed film and video cameras are used to capture actual test events. The optical data is then used for test analysis and documentation of the event.



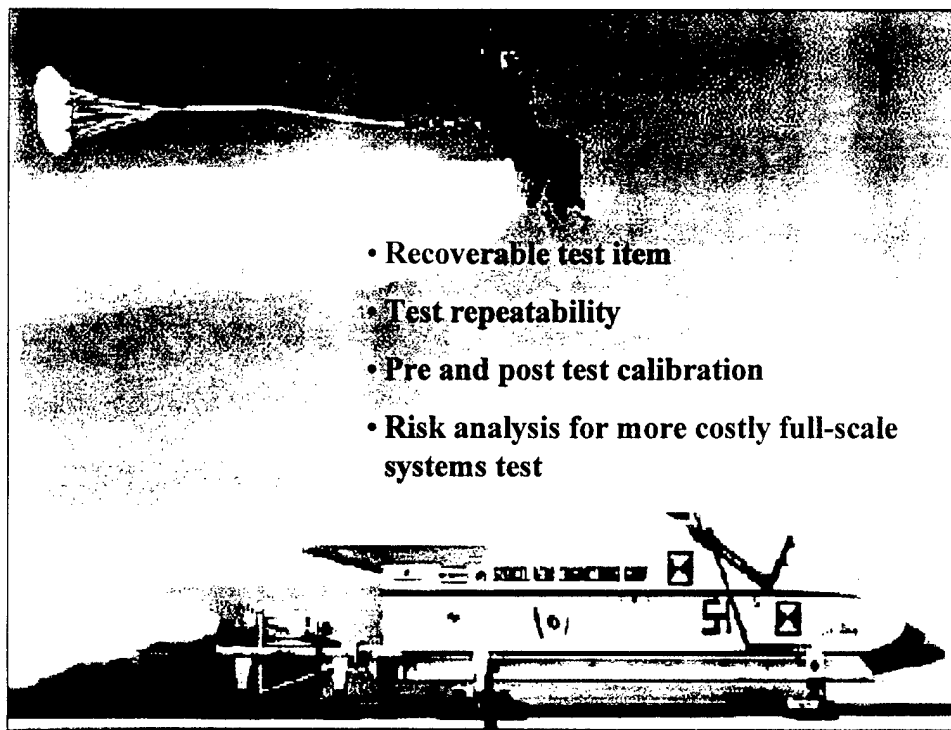
Crewstation modeling at the tower allows for full examination and evaluation of the seat escape path and envelope. The inclusion of anthropomorphic devices can demonstrate fit, range of motion, flailing, and potential body strike.

This configuration examined the foot well areas with the lower-g garment partially inflated.



Disconnect forces are measured for comparison to design specification and static test results.

Event timing from electronic and optical data can be used to determine the sequence of events.







## ESCAPE AND SURVIVABILITY INITIATIVES

- Aircrew night vision systems/helmet mounted displays
- Survival radios
- Aircraft escape/survivability improvements
- Mission configured survival vest
- Aircrew supplemental breathing/oxygen systems
- Aircrew environmental/ exposure protective systems
- Laser eye protection
- Communication improvements and noise attenuation

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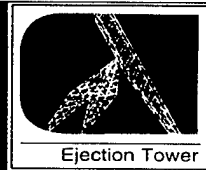
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From the War fighter's top ten list, these are eight of the initiatives that would include the ejection tower as part of the program test matrix.

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- If you would like to reach me
- Take questions